# $CO_2$ storage pilot project in a depleting hydrocarbon field in Czechia


Vít Hladík, Róbert Prochác (Czech Geological Survey),
Vladimír Opletal, Milan Pagáč (MND a.s.)
& the CO2-SPICER project team

CZECH GEOLOGICAL SURVEY

MND

VSB TECHNICAL UNIVERSITY OF OSTRAVA | FACULTY OF MINING AND GEOLOGY

INSTITUTE OF GEOPHYSICS OF THE CZECH ACADEMY OF SCIENCES

NORCE

Norway grants

TA ČR

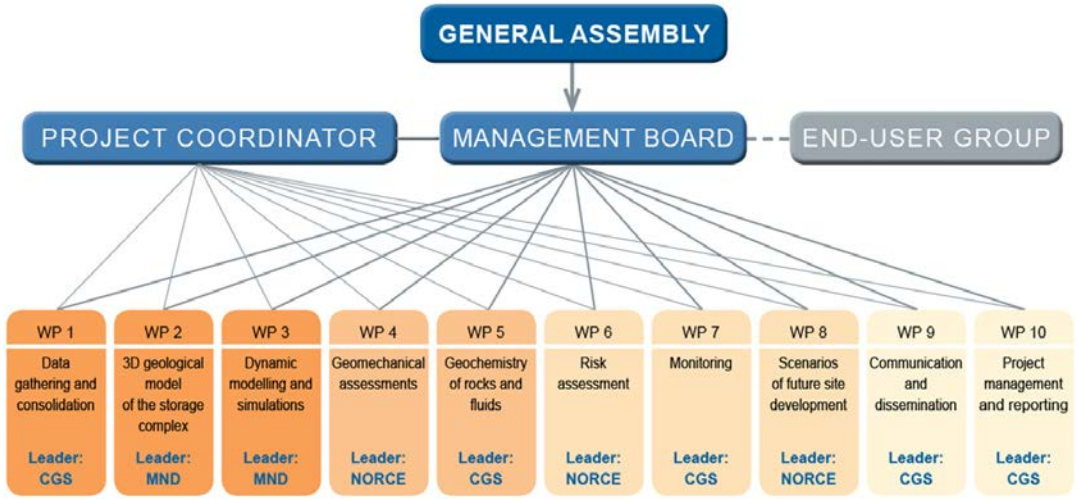
# Why a $CO_2$ storage pilot?

- Demonstration of the technology to local, national and regional stakeholders, including regulators and competent authorities
- Getting practical experience with site assessment, preparation, design of facilities and handling of $CO_2$
- Small-scale is more acceptable for the public when introducing a new technology
- Following good experience from elsewhere

WE NEED TO BREAK THROUGH WITH ONSHORE STORAGE IN CONTINENTAL EUROPE

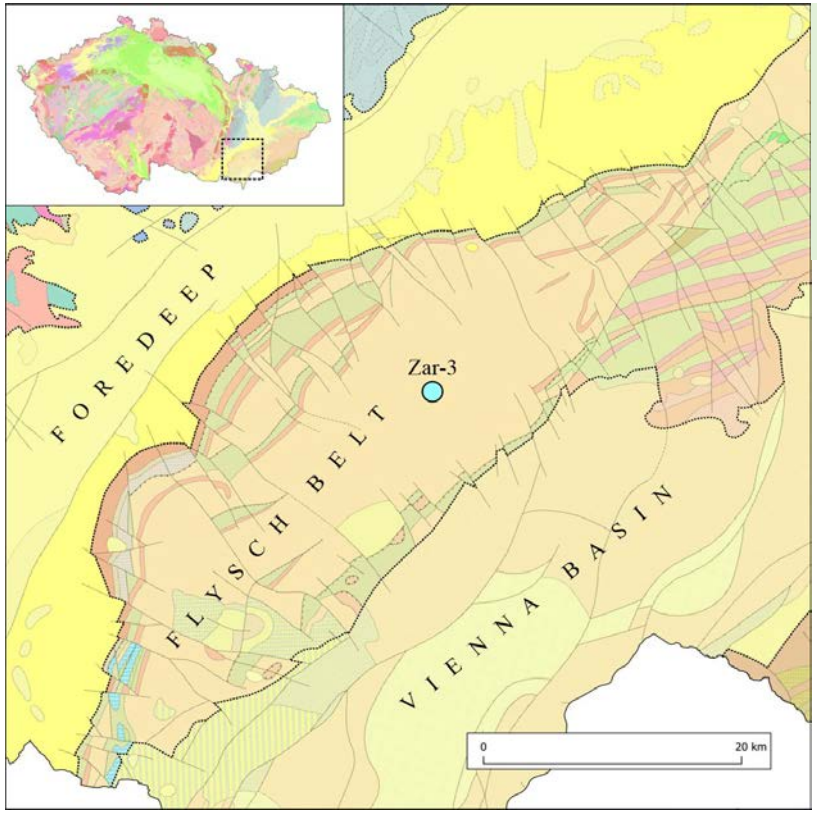
# CO2-SPICER project (2020-2024)

- Main project objective is to prepare implementation of a $CO_2$ geological storage pilot project at the mature Zar-3 oil and gas field (achieve implementation-ready stage)
- An important step towards the deployment of the CCS technology in Czechia and C&E Europe
- Workflow follows the requirements of the EU CCS Directive
- 10 Work Packages, 41 Tasks, 70 team members
- Start 11/2020 – end 4/2024



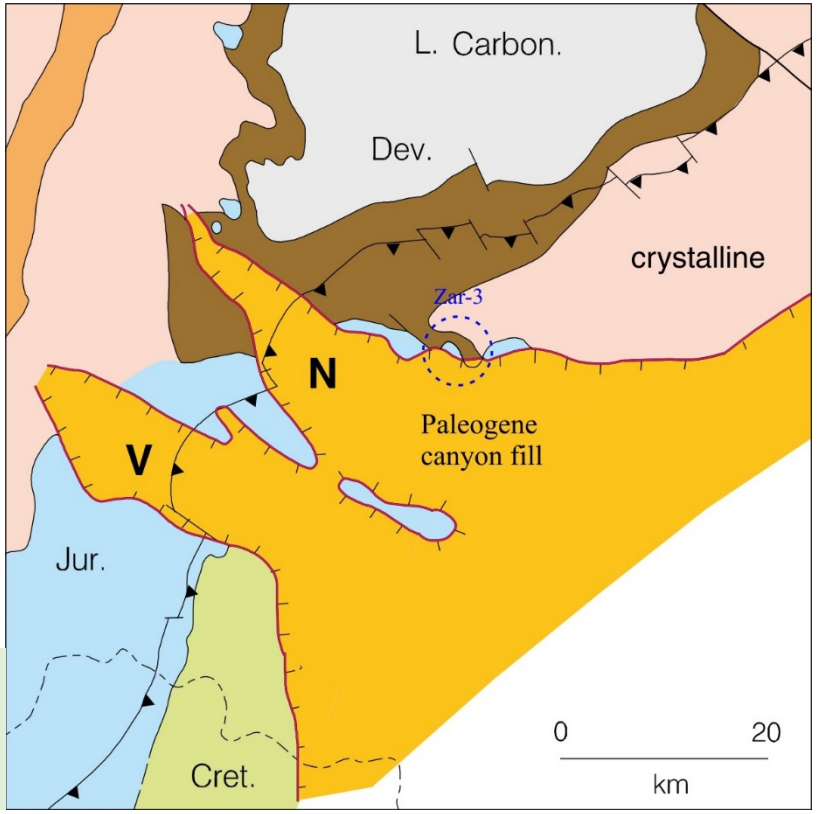
# Site location

- Zar-3 field is situated on the NE slope of the Nesvacilka depression, one of two incised canyons on the SE slopes of the Bohemian Massif




Position of Zar-3 site on geological map of the Czech Republic. Source: CGS ArcGIS server map services

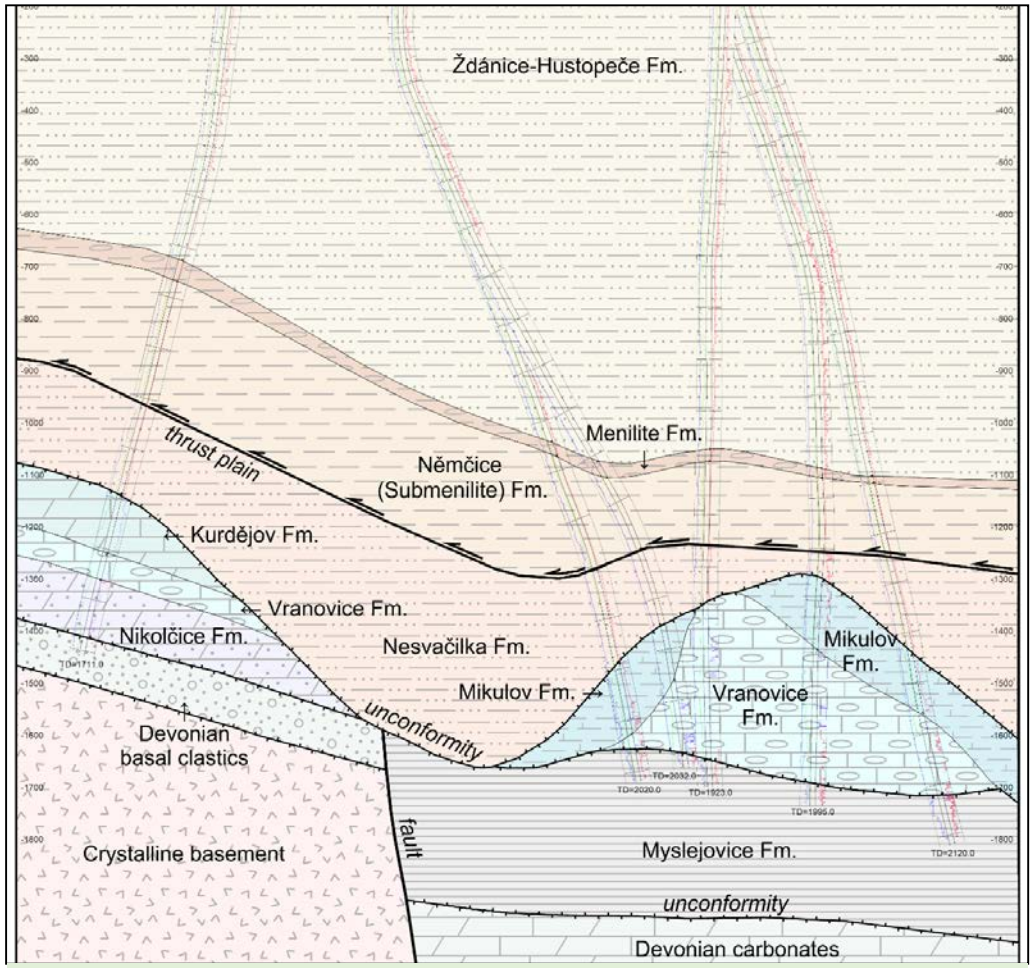
(http://www.geology.cz/extranet/mapy/mapy-online/esri).




Pre-Neogene subcrop map showing the Nesvacilka (N) and Vranovice (V) paleovalleys. Picha et al. (2006).

# Basic site geology and field parameters

- Oil field with a gas cap and an active aquifer, discovered in 2001
- Reservoir: Jurassic Vranovice carbonates (porosity: 2 – 20 %, Permeability: 190 – 630 mD)
- Lithology: Dolomites with some limestones and sandstones
- OOIP = 1.2 MMCM, GIIP = 100 MMCM (gas cap) + 77 MMCM
- Caprock: Paleogene pelites and Jurassic Mikulov marls




Geological section of NNW – SSE direction through the Zar-3 structure.

# CO2-SPICER project goals

- Construction of a 3D geological model of the storage complex
- Evaluate geomechanical and geochemical properties of the storage complex
- Dynamic modelling and simulation of CO2 injection in the reservoir using various scenarios
- Risk assessment related to CO2 storage on the pilot site
- Preparation of a site monitoring plan
- Evaluation of scenarios for future site development, including design of $CO_2$ injection facilities

# Data available

- 3D seismic cube, well data (from 22 wells) – well logs, core samples, pressure, temperature, fluid properties data, production data, etc.

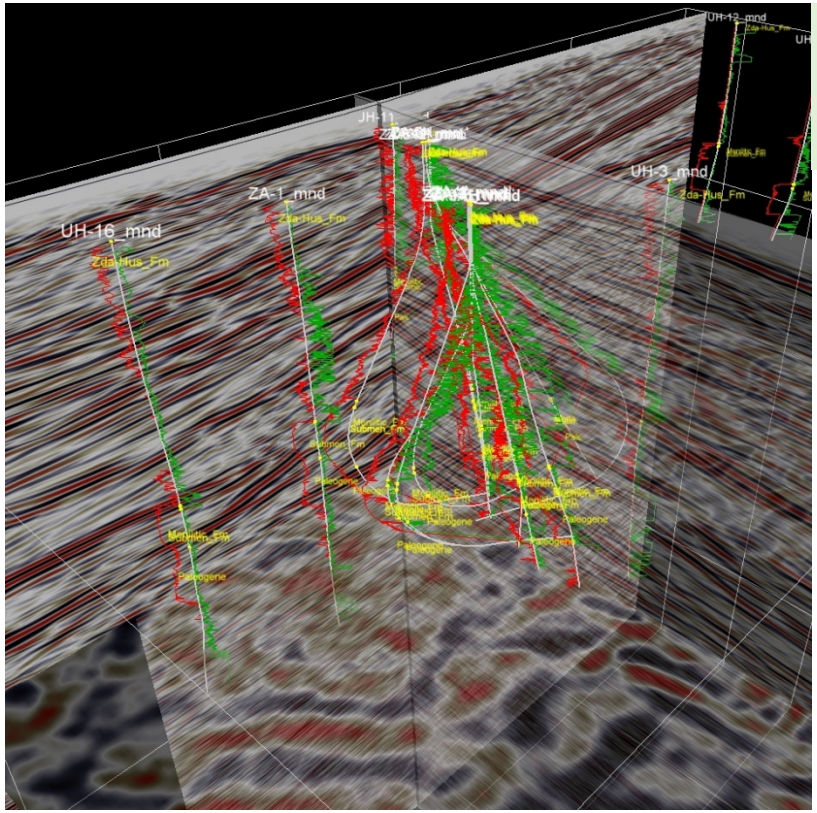
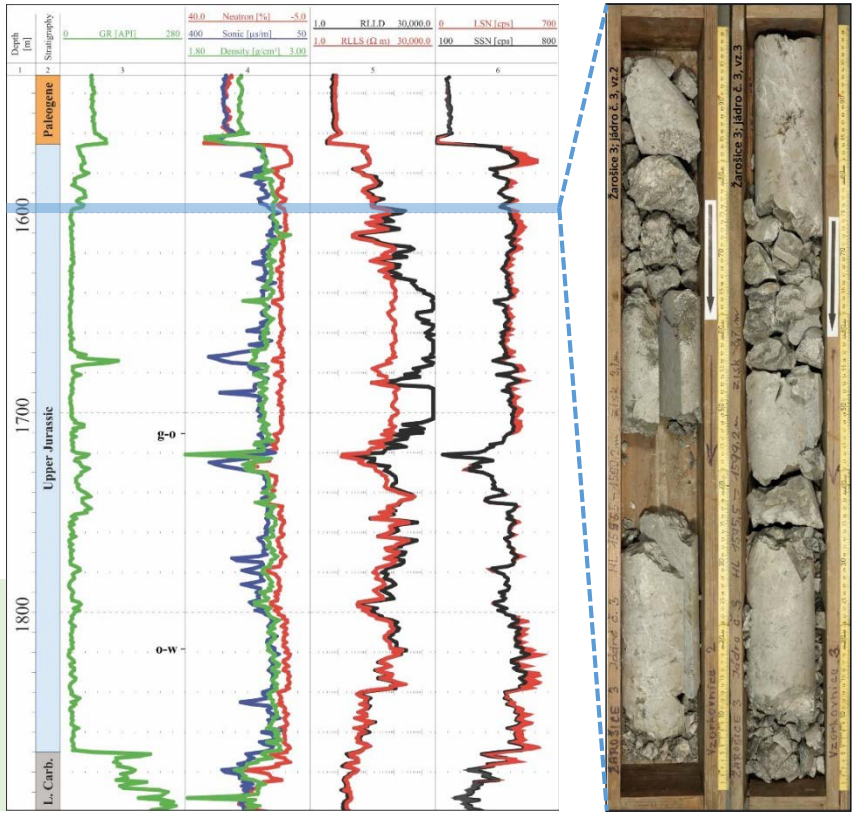



Illustration of data available from the Zar-3 field area – 3D seismics, wells with well logs and stratigraphy.



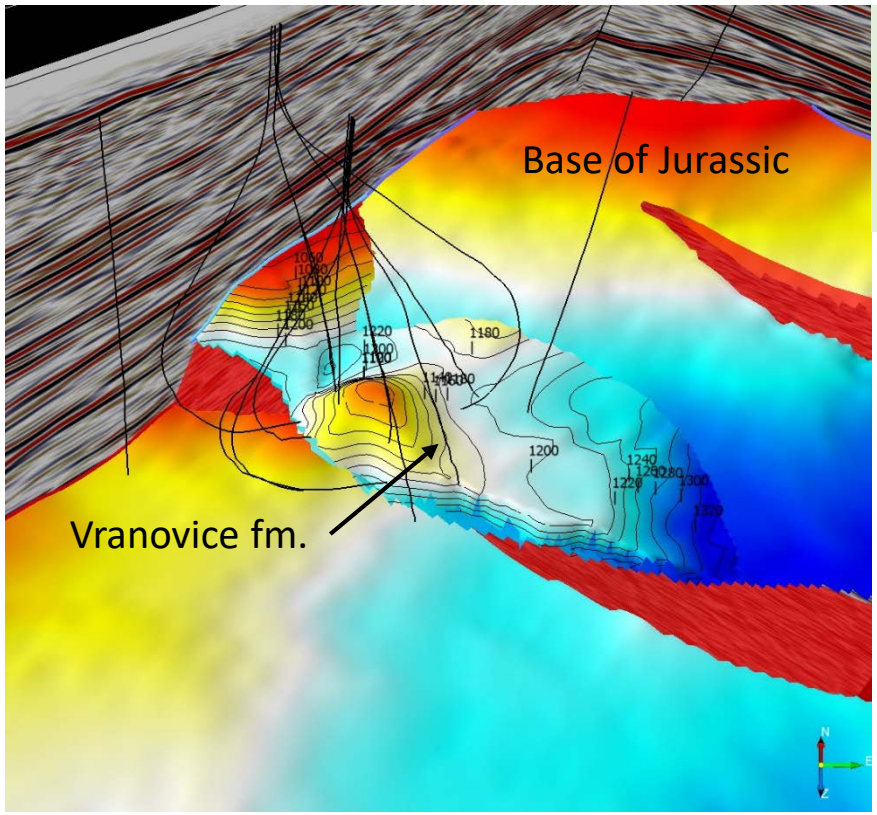

Well-logs of the reservoir (on the left, Kostelnicek et al. (2006)) and core samples from the upper part of the reservoir (on the right, photos from MND core repository).

# Tornado at Lužice on 24 June 2021

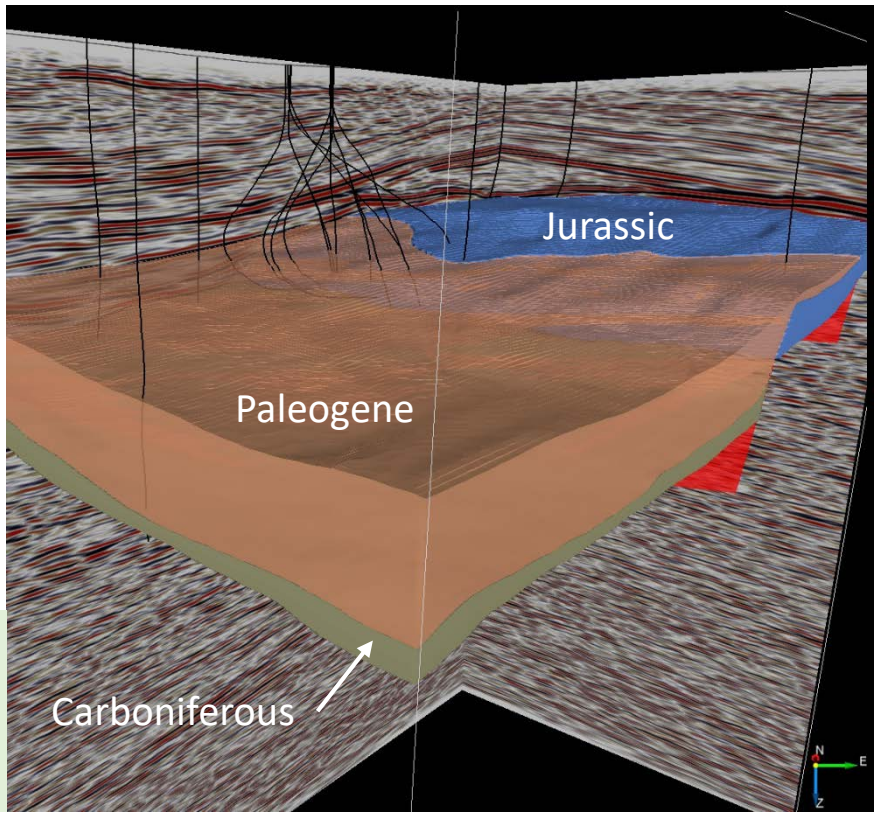

MND core repository and labs affected; availability of cores interrupted until winter → additional samples from caprock (incl. field analogues) were taken only in early 2022.

# Results to date – 3D seismic interpretation and mapping

- 3D seismic interpretation of the reservoir top and base and main (litho)stratigraphic surfaces in the reservoir under and overburden



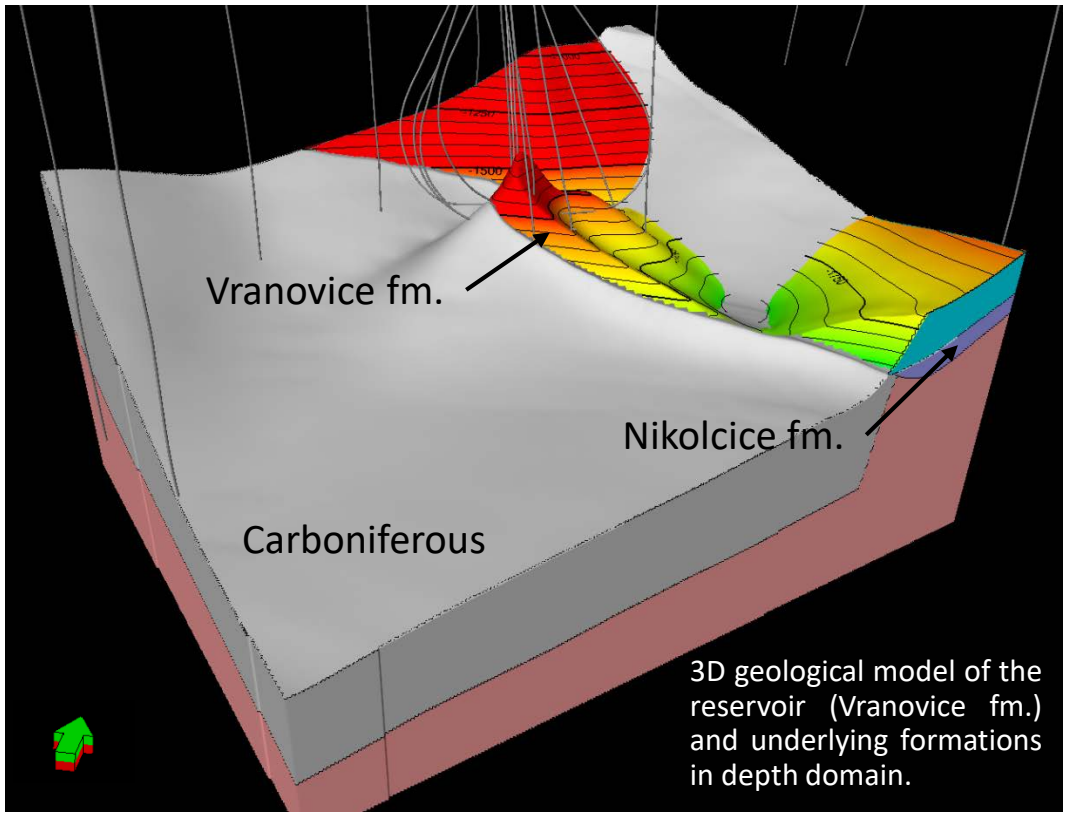

Stratigraphic surfaces and the reservoir (Vranovice fm.) top surface interpreted from 3D seismic data, shown in time domain.



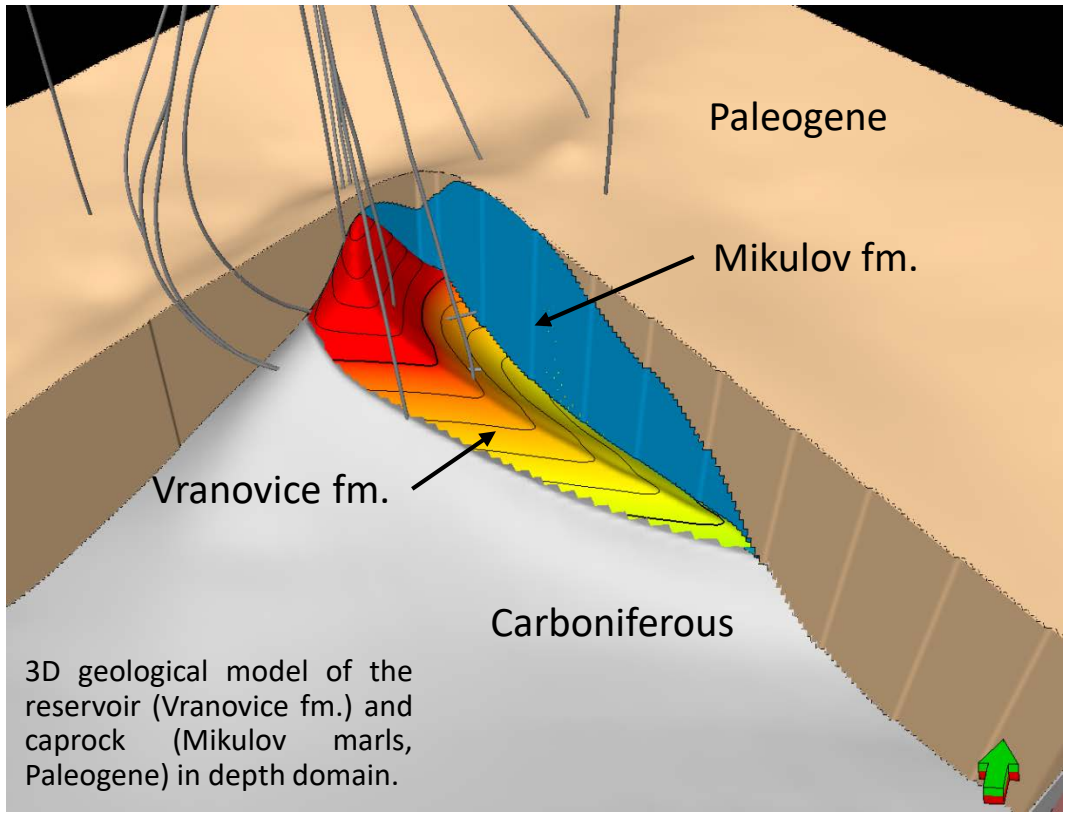

3D model of geological formations in the study area based on 3D seismic interpretaion, displayed in time domain.

# Results to date – 3D geological model

- Static 3D geological model of the storage complex and its under and overburden based on seismic and detailed well data interpretation



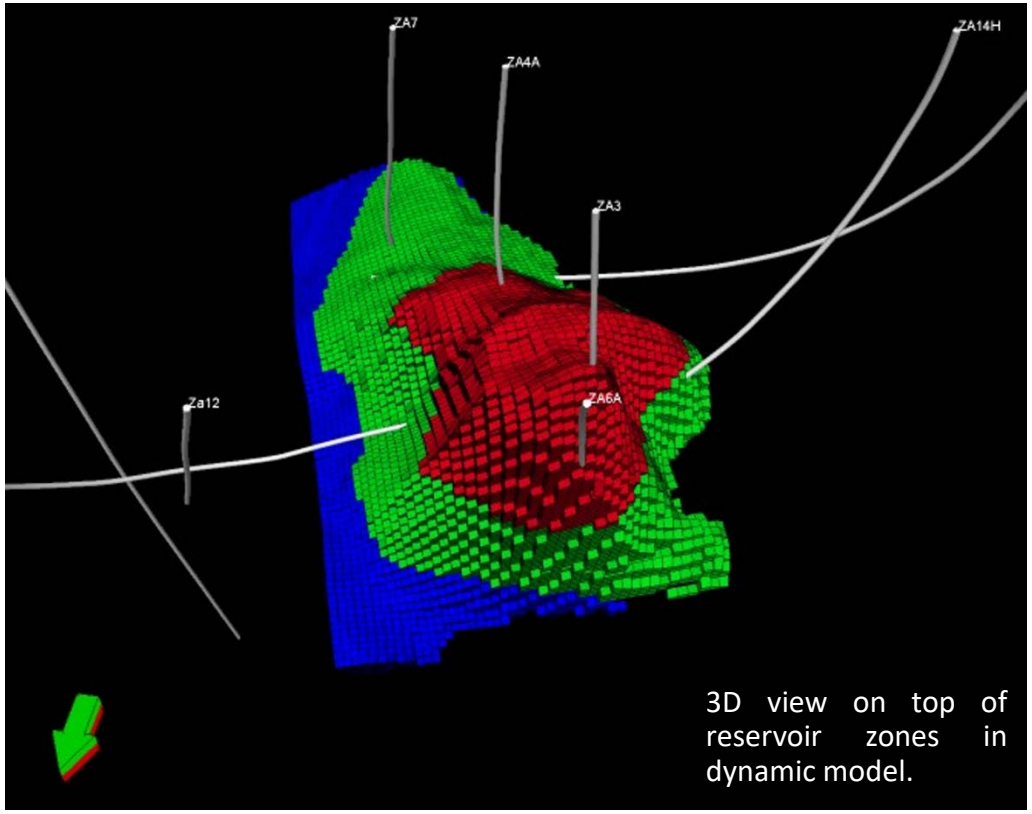

3D geological model of the reservoir (Vranovice fm.) and underlying formations in depth domain.



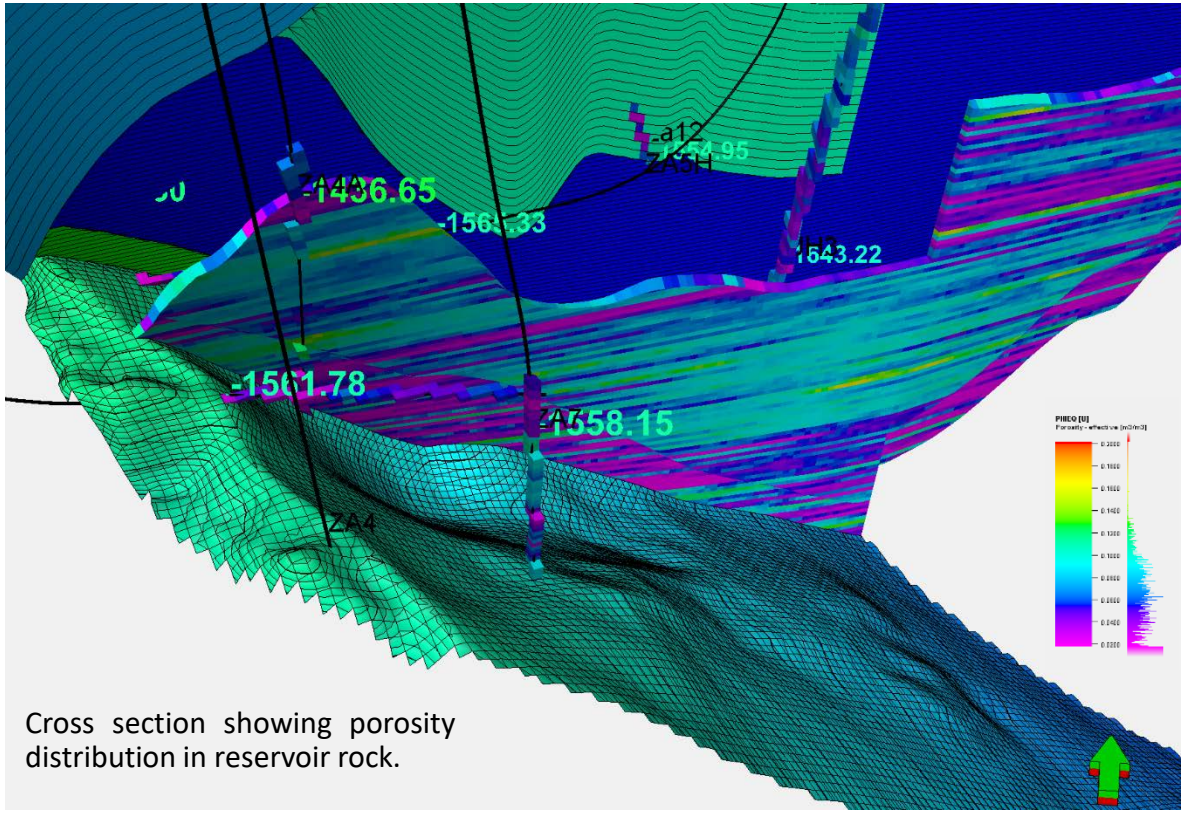

3D geological model of the reservoir (Vranovice fm.) and caprock (Mikulov marls, Paleogene) in depth domain.

# Results to date – dynamic model

- Preparation of inputs for the dynamic model, distribution of porosity and permeability within the reservoir rock

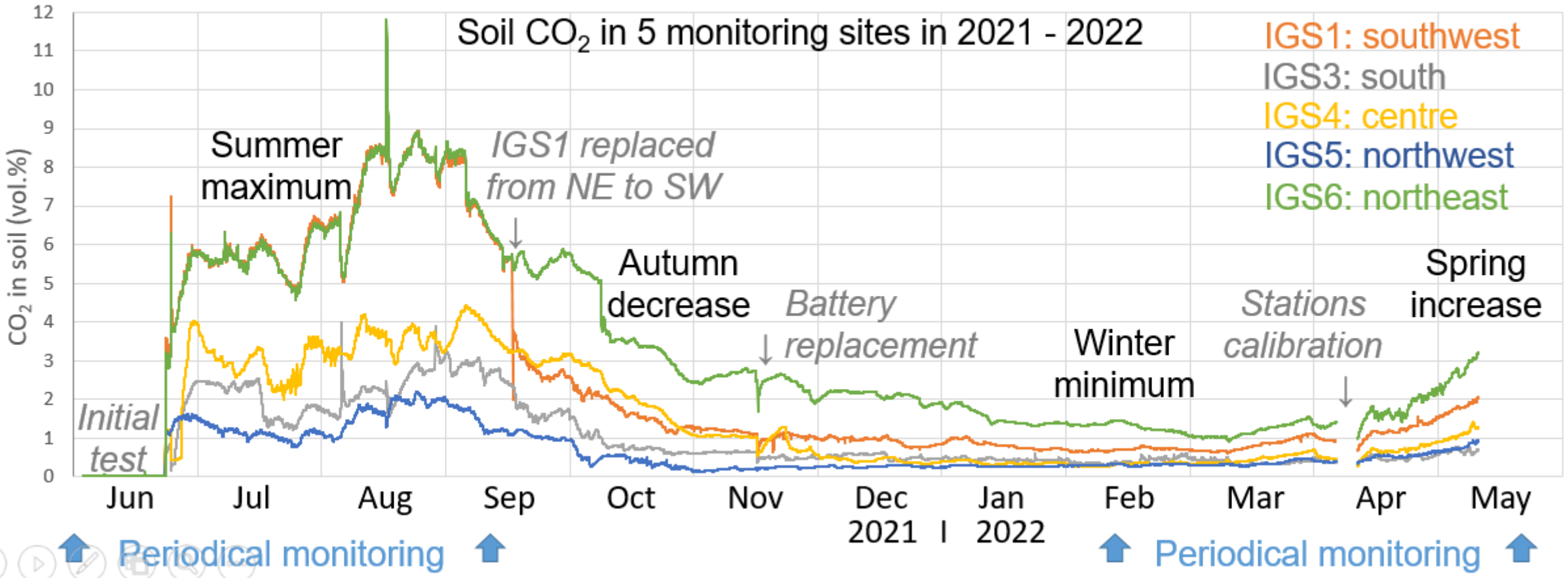



3D view on top of reservoir zones in dynamic model.




Cross section showing porosity distribution in reservoir rock.

# Results to date – atmogeochemical monitoring




CO2 concentrations in soil gas measured by permanent monitoring stations

# Results to date – seismic monitoring

Current seismicity observed by permanent network – five stations since Aug 2021, planned to Aug 2022, prolonged to summer 2023 + six temporal stations (November 2021 + May 2022)

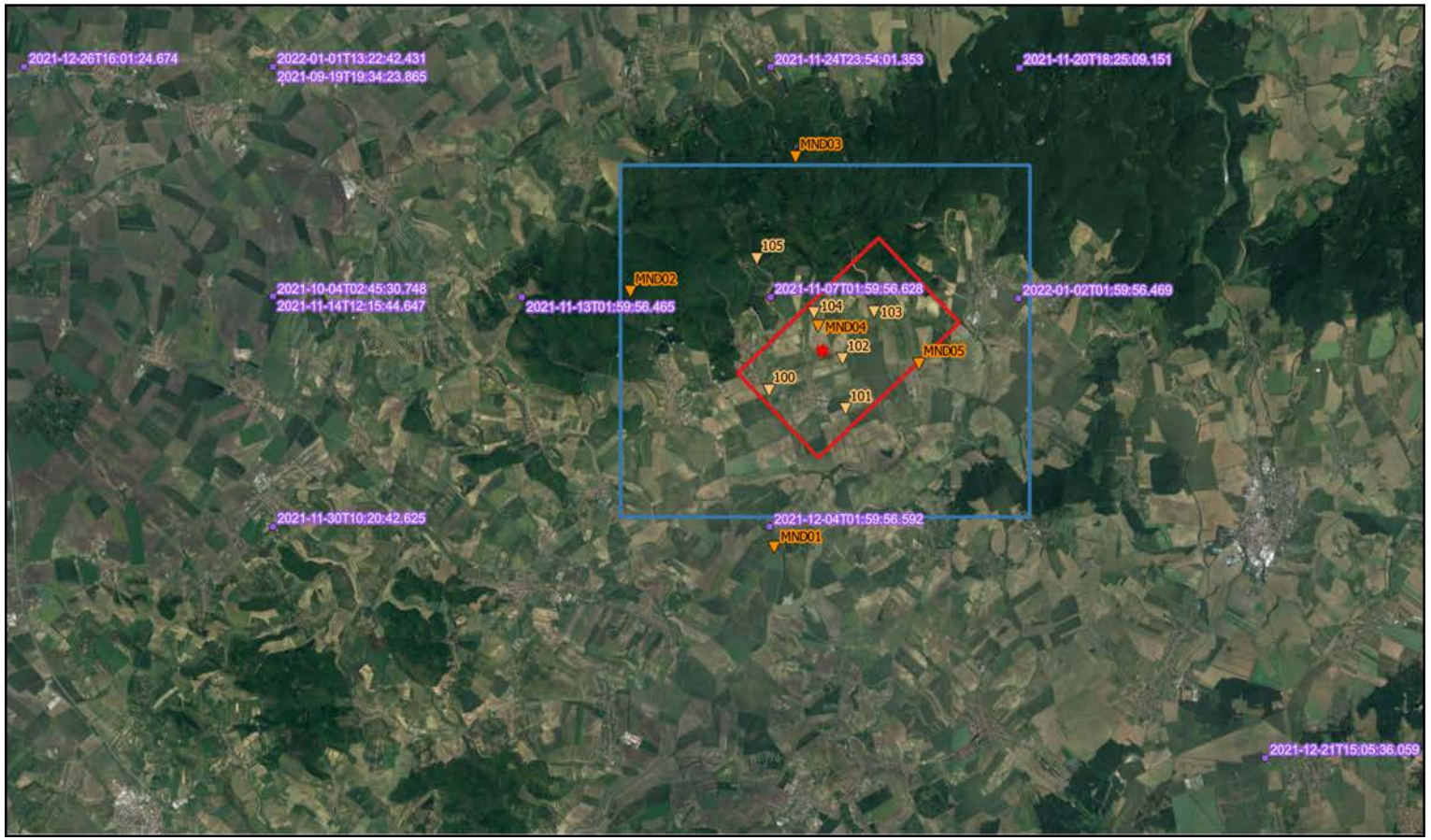
Seismic monitoring station

... powered by solar panel

Temporal station installation

# Results to date – seismic monitoring

## Newly detected seismic events near the field:




| Origin time | Latitude | Longitude | Depth |
|---|---|---|---|
| 21-09-19 19:34:23.865 | 49.1157 | 16.7782 | 20 |
| 21-10-04 02:45:30.748 | 49.0629 | 16.7782 | 20 |
| 21-10-08 21:57:22.408 | 49.1686 | 16.8655 | 18 |
| 21-10-27 01:46:46.431 | 49.1681 | 17.1277 | 0 |
| 21-11-04 09:29:29.418 | 49.2214 | 16.8656 | 20 |
| 21-11-07 01:59:56.628 | 49.0628 | 16.9526 | 20 |
| 21-11-13 01:59:56.465 | 49.0628 | 16.8654 | 20 |
| 21-11-14 12:15:44.647 | 49.0629 | 16.7782 | 20 |
| 21-11-20 18:25:09.151 | 49.1155 | 17.0401 | 18 |
| 21-11-24 23:54:01.353 | 49.1156 | 16.9528 | 0 |
| 21-11-30 10:20:42.625 | 49.0100 | 16.7782 | 18 |
| 21-12-04 01:59:56.592 | 49.0099 | 16.9525 | 20 |
| 21-12-21 15:05:36.059 | 48.9567 | 17.1263 | 0 |
| 21-12-26 16:01:24.674 | 49.1157 | 16.6909 | 0 |
| 22-01-01 13:22:42.431 | 49.1157 | 16.7782 | 18 |
| 22-01-02 01:59:56.469 | 49.0626 | 17.0398 | 20 |
| 22-01-07 17:55:30.035 | 49.1686 | 16.7782 | 20 |
| 22-01-13 14:44:57.256 | 49.2212 | 17.0406 | 0 |
| 22-01-14 16:20:34.918 | 49.1686 | 16.8655 | 20 |

# Scenarios of future site development

- Basic pilot scenario – tens of kt $CO_2$ (100,000 t limit)
- Full-scale structure utilization – adjusted to expected $CO_2$ delivery

WHERE TO GET THE $CO_2$ FROM?

- Original plans based on Russian gas failed
- New plans under discussion – DACCS, part of larger cluster

WHAT TO DO WITH THE REMAINING HYDROCARBONS?

- The gas cap still in place + the remaining oil in the oil zone
- Transition from production to storage regulatory unclear
- Any $CO_2$-EOR disqualifies the project from public funding

# Summary / Lessons learned

- Carbonate environment raises special requirements – modelling, geochemistry, monitoring
- Focus on caprock might be surprising for HC practitioners
- Lack of geotechnical data can be a complicating factor
- Demonstration of the technology „locally“ is necessary
- Interest of emitters in CCS as a solution is rising in whole CEE region
- Storage sites are not ready → investment in assessment and preparation of storage sites is needed (PPP)
- Current regulatory framework for transition from HC production to $CO_2$ storage is unclear and discouraging

# Acknowledgement

The CO2-SPICER project benefits from a € 2.32 mil. grant from Norway and Technology Agency of the Czech Republic.

PROJECT PARTNERS

CZECH GEOLOGICAL SURVEY

COORDINATOR

MND

VSB TECHNICAL UNIVERSITY OF OSTRAVA | FACULTY OF MINING AND GEOLOGY

INSTITUTE OF GEOPHYSICS OF THE CZECH ACADEMY OF SCIENCES

NORCE

Norway grants

Programme Kappa

TA ČR